

## CLAIMS

We claim:

1. A chemical protective covering comprising a laminate comprising  
a layer comprising at least a sulfonated aromatic polymer, wherein the polymer comprises  
at least one repeating aromatic group selected from 5, 6, or 7 membered single or fused rings having 0, 1, 2, 3, or, 4 heteroatoms selected from N, O or S, and at least a portion of the aromatic groups having at least one pendant group comprising sulfonic acid, or its salt,  
wherein the polymer has a sulfonic acid equivalent weight of about 200-1000 (IEC: 1.0-5.0 meq/g), and  
at least one additional layer laminated to the layer comprising the sulfonated aromatic polymer,  
wherein the laminate is capable of transmitting moisture vapor and resisting chemical permeation.
2. The chemical protective covering of claim 1, wherein the covering is an article of apparel or enclosure.
3. The chemical protective covering of claim 2, wherein the article of apparel or enclosure is selected from outer wear, under wear, jackets, pants, gloves, foot wear, and hoods.
4. The chemical protective covering of claim 2, wherein the enclosure is selected from tents, sleeping bags, casualty bags, and shelters.
5. The chemical protective covering of claim 1 wherein the at least one additional layer comprises at least one layer selected from fabric, membrane and film.
6. The chemical protective covering of claim 1, wherein the at least one additional layer is at least one layer of fabric selected from knit, woven or non-woven apparel fabrics comprising synthetic or natural fibers of polymers selected from poly(aliphatic amide), poly(aromatic amide), polyester, polyolefin, wool, cellulose based fibers, modified cellulose, polyurethane, acrylics, modacrylics, and a blend thereof.

7. The chemical protective covering of claim 1 having a moisture vapor transmission rate of greater than or equal to about 600 g/m<sup>2</sup>/day.
8. The chemical protective covering of claim 1 having a moisture vapor transmission rate of greater than or equal to about 2000 g/m<sup>2</sup>/day.
9. The chemical protective covering of claim 1, having a permeability to bis-2-chloroethyl sulfide of less than or equal to 100 µg/cm<sup>2</sup> over a 20 hour period.
10. The chemical protective covering of claim 1, having a permeability to bis-2-chloroethyl sulfide of less than or equal to 30 µg/cm<sup>2</sup> over a 20 hour period.
11. The chemical protective covering of claim 1, having a permeability to bis-2-chloroethyl sulfide of less than or equal to 10 µg/cm<sup>2</sup> over a 20 hour period.
12. The chemical protective covering of claim 1, having a permeability to pinacolyl methylphosphono fluoridate of less than or equal to 30 µg/cm<sup>2</sup> over a 20 hour period.
13. The chemical protective covering of claim 1, having a permeability to pinacolyl methylphosphono fluoridate of less than or equal to 10 µg/cm<sup>2</sup> over a 20 hour period.
14. The chemical protective covering of claim 1, having a permeability to pinacolyl methylphosphono fluoridate of less than or equal to 5 µg/cm<sup>2</sup> over a 20 hour period.
15. The chemical protective covering of claim 1 wherein the sulfonated aromatic polymer has a sulfonic acid equivalent weight of about 400-800 (IEC: 1.25-2.5 meq/g).
16. The chemical protective covering of claim 1 wherein at least a portion of the aromatic groups are linked by one or more linkages comprising ketone, sulfone, ether, sulfide, urethane, amide, imide, ester, substituted or unsubstituted saturated or unsaturated C<sub>1-5</sub> alkylene, substituted or unsubstituted phosphine, and phosphine oxide groups.

17. The chemical protective covering of claim 1 wherein at least a portion of the aromatic groups have one or more substitutions selected from C<sub>1</sub>-C<sub>8</sub> alkyl and haloalkyl, aryl, ketone, hydroxyl, halogen, amine, cyanide, nitrile, sulfide, carbonyl, C<sub>1</sub>-C<sub>8</sub> ester, and C<sub>1</sub>-C<sub>8</sub> alkoxyl group.
18. The chemical protective covering of claim 1, wherein the sulfonated aromatic polymer is crosslinked.
19. The chemical protective covering of claim 1, wherein the sulfonated aromatic polymer is ionically crosslinked.
20. The chemical protective covering of claim 1, wherein the layer comprising the sulfonated aromatic polymer comprises at least one additional component.
21. The chemical protective covering of claim 1, wherein the layer comprising the sulfonated aromatic polymer is a composite comprising a sulfonated aromatic polymer and at least one substrate.
22. The chemical protective covering of claim 20, wherein the at least one substrate is expanded polytetrafluoroethylene (ePTFE).
23. The chemical protective covering of claim 21, wherein the sulfonated aromatic polymer has a sulfonic acid equivalent weight of about 400-800 (IEC: 1.25-2.5 meq/g).
24. A chemical protective article of apparel or enclosure for use in reducing exposure to chemicals comprising a fabric laminate capable of transmitting water vapor comprising
  - at least one layer of apparel fabric laminated to
  - a layer comprising at least a sulfonated aromatic polymer wherein the polymer comprises at least one repeating aromatic group selected from 5, 6, or 7 membered single or fused rings having 0, 1, 2, 3, or 4 heteroatoms selected from N, O or S, and at least a portion of the aromatic groups having at least one pendant group comprising sulfonic acid, or its salt, wherein the polymer has a sulfonic acid equivalent weight of about 200 - 1000 (IEC: 1.0-5.0 meq/g), and wherein the fabric

laminate has a permeation to bis-2-chloroethyl sulfide of less than or equal to about  $100 \mu\text{g}/\text{cm}^2$ .

25. The chemical protective article of apparel or enclosure of claim 24 wherein the layer comprising the sulfonated aromatic polymer has a permeation to bis-2-chloroethyl sulfide of less than or equal to about  $30 \mu\text{g}/\text{cm}^2$  over a 20 hour period.
26. The chemical protective article of apparel or enclosure of claim 24 wherein the layer comprising the sulfonated aromatic polymer has a permeation to bis-2-chloroethyl sulfide of less than or equal to about  $10 \mu\text{g}/\text{cm}^2$  over a 20 hour period.
27. The chemical protective article of apparel or enclosure of claim 24 wherein the at least one layer of apparel fabric is selected from knit, woven and non-woven apparel fabrics.
28. The chemical protective article of apparel or enclosure of claim 24 comprising at least two layers of apparel fabric.
29. The chemical protective article of apparel or enclosure of claim 24 wherein the at least one layer of apparel fabrics comprises synthetic or natural fibers of polymers selected from poly(aliphatic amide), poly(aromatic amide), polyester, polyolefin, wool, cellulose based fibers, modified cellulose, polyurethane, acrylics, modacrylics, and a blend thereof.
30. The chemical protective article of apparel or enclosure of claim 24 wherein the article of apparel is selected from outer wear, under wear, jackets, pants, gloves, foot wear, and hoods.
31. The chemical protective article of apparel or enclosure of claim 24 wherein the enclosure is selected from tents, sleeping bags, casualty bags and structures.
32. The chemical protective article of apparel or enclosure of claim 24 wherein at least a portion of the aromatic groups are linked by one or more linkages comprising ketone, sulfone, ether, sulfide, urethane, amide, imide, ester,

substituted or unsubstituted saturated or unsaturated C<sub>1-5</sub> alkylene,  
substituted or unsubstituted phosphine, and phosphine oxide groups.

33. The chemical protective article of apparel or enclosure of claim 24 wherein at least a portion of the aromatic groups are linked by one or more linkages comprising ketone, sulfone, imide and ether.
34. The chemical protective article of apparel or enclosure of claim 24 wherein at least a portion of the aromatic groups have one or more substitutions selected from C<sub>1</sub>-C<sub>8</sub> alkyl and haloalkyl, aryl, ketone, hydroxyl, halogen, amine, cyanide, nitrile, sulfide, carbonyl, C<sub>1</sub>-C<sub>8</sub> ester and C<sub>1</sub>-C<sub>8</sub> alkoxy groups.
35. The chemical protective article of apparel or enclosure of claim 24 wherein the sulfonated aromatic polymer has a sulfonic acid equivalent weight of about 400-800 (IEC: 1.25 - 2.5 meq/g).
36. The chemical protective article of apparel or enclosure of claim 24 wherein the layer comprising the sulfonated aromatic polymer is a composite comprising the sulfonated aromatic polymer and at least one substrate.
37. The chemical protective article of apparel or enclosure of claim 36 wherein the at least one substrate of the composite is a porous substrate.
38. The chemical protective article of apparel or enclosure of claim 36 wherein the at least one substrate of the composite is an expanded polytetrafluoroethylene (ePTFE) membrane.
39. The chemical protective article of apparel or enclosure of claim 36 wherein at least a portion of the sulfonated aromatic polymer resides partially or fully in the expanded polytetrafluoroethylene (ePTFE) membrane.
40. The chemical protective article of apparel or enclosure of claim 38 wherein the layer having the sulfonated aromatic polymer is a composite comprising the sulfonated aromatic polymer and at least two substrates.

41. A chemical protective article of apparel or enclosure for use in reducing exposure of a person to harmful chemicals comprising a fabric laminate capable of transmitting moisture vapor and resisting permeation by harmful chemicals comprising
- at least one layer of apparel fabric laminated to
  - a layer comprising a sulfonated aromatic polymer, the sulfonated aromatic polymer comprising repeat units selected from sulfonated polyether sulfone, sulfonated polyether ketone, sulfonated biphenyl sulfone, sulfonated polyphthalazinone ether ketone, sulfonated polyimide, sulfonated polybenzimidazole, and sulfonated polyphenylene oxide, wherein the sulfonated aromatic polymer has a sulfonic acid equivalent weight of about 200-1000 (IEC: 1.0 – 5.0 meq/g), and
  - wherein the fabric laminate has a permeation to bis-2-chloroethyl sulfide of less than or equal to about  $100 \mu\text{g}/\text{cm}^2$  over a 20 hour period.
42. The chemical protective article of apparel or enclosure of claim 41 wherein the at least one layer of apparel fabric is selected from knit, woven and non-woven apparel fabrics.
43. The chemical protective article of apparel or enclosure of claim 41 wherein the at least one layer of apparel fabric comprises synthetic or natural fibers of polymers selected from poly(aliphatic amide), poly(aromatic amide), polyester, polyolefin, wool, cellulose based fibers, modified cellulose, polyurethane, acrylics, modacrylics, and a blend thereof.
44. The chemical protective article of apparel or enclosure of claim 41 comprising at least two layers of apparel fabric.
45. The chemical protective article of apparel of claim 41 wherein the fabric laminate is waterproof.
46. The chemical protective article of apparel or enclosure of claim 41 wherein the fabric laminate is an article of apparel selected from outer wear, under wear, jackets, pants, gloves, foot wears, and hoods.
47. The chemical protective article of apparel or enclosure of claim 41 wherein the fabric laminate has a permeation to bis-2-chloroethyl sulfide of less than or equal to about  $30 \mu\text{g}/\text{cm}^2$  over a 20 hour period.

48. The chemical protective article of apparel or enclosure of claim 41 wherein the layer comprising the sulfonated aromatic polymer is a composite of a sulfonated aromatic polymer and at least one substrate.
49. The chemical protective article of apparel or enclosure of claim 48 wherein at least one substrate is porous or microporous.
50. The chemical protective article of apparel or enclosure of claim 49 wherein at least one substrate is expanded polytetrafluoroethylene (ePTFE).
51. The chemical protective article of apparel or enclosure of claim 48 comprising at least two substrates comprising expanded polytetrafluoroethylene (ePTFE).
52. The chemical protective article of apparel or enclosure of claim 41 wherein the fabric laminate has a sulfonic acid equivalent weight of about 400-800 (IEC: 1.25-2.5 meq/g).
53. A method of reducing exposure of a person to chemicals comprising interposing a chemical protective covering between a person and a noxious or harmful chemical, wherein the chemical protective covering comprises a fabric laminate comprising  
at least one layer of apparel fabric laminated to  
a layer comprising at least a sulfonated aromatic polymer,  
wherein the polymer comprises at least one repeating aromatic group selected from 5, 6, or 7 membered single or fused rings having 0, 1, 2, 3, or 4 heteroatoms selected from N, O or S, and at least a portion of the aromatic groups having at least one pendant group comprising sulfonic acid, or its salt,  
wherein the sulfonated aromatic polymer has a sulfonic acid equivalent weight of about 200-1000 (IEC: 1.0 - 5.0 meq/g), and the laminate has a permeation to bis-2-chloroethyl sulfide of less than or equal to about 100  $\mu\text{g}/\text{cm}^2$  over a 20 hour period.
54. The method of claim 53 wherein the chemical protective covering is an article of apparel or enclosure.

55. The method of claim 53 wherein the chemical protective covering is an article of apparel.
56. The method of claim 53 wherein the sulfonated aromatic polymer has a sulfonic acid equivalent weight of about 400-800 (IEC: 1.25-2.5meq/g).
57. The method of claim 53 wherein the fabric laminate has a permeation to bis-2-chloroethyl sulfide of less than or equal to about 30  $\mu\text{g}/\text{cm}^2$  over a 20 hour period.
58. The method of claim 53 wherein the sulfonated aromatic polymer has repeat units selected from sulfonated polyether sulfone, sulfonated polyether ketone, sulfonated biphenyl sulfone, sulfonated polyphthalazinone ether ketone, sulfonated polyimide, sulfonated polybenzimidazole, and sulfonated polyphenylene oxide.
59. The method of claim 53 wherein the sulfonated aromatic polymer comprises a blend of sulfonated and non-sulfonated polymers.
60. The method of claim 53 wherein the layer comprising the sulfonated aromatic polymer is a composite comprising at least one substrate selected from porous and microporous substrates.
61. The method of claim 60 wherein the at least one substrate is selected from porous polytetrafluoroethylene (expanded PTFE), polyurethane, polyamides, polyimides, polysulfones, and polyolefins.
62. The method of claim 61 wherein the at least one substrate is expanded polytetrafluoroethylene (ePTFE).
63. The method of claim 60 wherein the composite comprises at least two substrates comprising expanded polytetrafluoroethylene (ePTFE).
64. The method of claim 53 comprising at least two layers of apparel fabric.
65. The method of claim 53 comprising covering at least a portion of a person who may be exposed to a harmful chemical with a chemical protective article of apparel having a fabric laminate comprising a layer having a



sulfonated aromatic polymer with a sulfonic acid equivalent weight of about 400-800 (IEC: 1.25 – 2.5 meq/g), wherein the fabric laminate has a permeation to bis-2-chloroethyl sulfide of less than or equal to about 30  $\mu\text{g}/\text{cm}^2$  over a 20 hour period.